REMARKS

Claims 35 and 36 have been amended to correct typographical errors. Claim 1 has been amended. Support for the amendment can be found in the specification for example at page 2, lines 21-22. No new matter has been added. Claims 1-50 are pending with claims 1, 15, 24, 32, 43, 45, and 48 being independent.

Claim Objections

Applicants believe that the amendments to claims 35 and 36 have addressed the Examiner's objection at page 2 of the Office Action. Withdrawal of this objection is respectfully requested.

Rejections Under 35 U.S.C. § 103(a)

Claims 1-23, and 49

Claims 1-23, and 49 have been rejected under 35 U.S.C. § 103(a) as being unpatentable over U.S. Patent 5,986,272 to Britton, Jr. *et al.* ("Britton") in view of U.S. Patent No. 6,274,323 to Bruchez et al ("Bruchez"). See Office Action at page 2. Claims 1 and 15 are independent.

Applicants have discovered a method of sensing temperature that includes providing a temperature sensor, where the temperature sensor is made up of a matrix on a surface of a substrate and the matrix is made up of a semiconductor nanocrystal and a binder. The method includes irradiating a portion of the sensor with an excitation wavelength of light, detecting the emission intensity of light from the sensor and determining the temperature from the emission intensity of the light. See independent claim 1.

Applicants have also discovered a temperature sensor that includes a matrix containing a semiconductor nanocrystal, where the matrix includes a semiconductor nanocrystal and a binder, a light source arranged to illuminate the semiconductor, and a detector arranged to detect light emitted from the semiconductor nanocrystal. See independent claim 15.

The Examiner recognizes that "Britton does not disclose the temperature sensor being a semiconductor nanocrystal in a binder." See Office Action at page 3. The Examiner then asserts that

> ...it would have been obvious to one having ordinary skill in the art at the time the invention was made to utilize the semiconductor nanocrystal in a binder as disclosed by Bruchez, as the luminescent coating in the temperature-measuring

apparatus disclosed by Britton, since these coatings are alternative types of luminescent coatings that can determine the temperature of a substrate.

Applicants respectfully disagree. Neither Britton nor Bruchez teach or suggest a method of sensing temperature including a temperature sensor including a semiconductor nanocrystal in a binder or suggest a temperature sensor that is a matrix that includes a semiconductor nanocrystal and a binder.

The Examiner relies on Britton for teaching all aspects of independent claims 1 and 15 except for the matrix including a semiconductor nanocrystal in a binder. However, Britton describes a "method and apparatus for determining the decay-time constant of a fluorescing phosphor." See column 2, lines 12-13 of Britton. Britton does not teach detecting the emission intensity of light from a temperature sensor and determining the temperature from the emission intensity of light. In fact, Britton determines the temperature by observing the decay-time constant of the fluorescing phosphor. This type of determination is completely different than the emission intensity-temperature determination of claim 1. Furthermore, Britton does not teach or suggest that a method such as the method of claim 1 would work for emissive compounds and does not motivate one skilled in the art to try any method beyond the decay-time method.

In addition, Britton also does not teach or suggest providing a temperature sensor including a matrix on a surface of a substrate, the matrix including a semiconductor nanocrystal in a binder. Britton vaguely discusses deposition of a phosphor on a piece of metal, but does not indicate any method of accomplishing this deposition. See column 9, lines 33-67. Thus, Britton fails to teach or suggest a temperature sensor including a matrix on a surface of a substrate, the matrix including a semiconductor nanocrystal in a binder. Indeed, there is no motivation provided in Britton to form a temperature sensor including a matrix on a surface of a substrate including a semiconductor nanocrystal in a binder in Britton.

Bruchez does not even relate to sensing temperature. Instead, Bruchez teaches a method of detecting an analyte in a sample. See Title of Bruchez. Bruchez does not teach or suggest forming a temperature sensor including a matrix on the surface of a substrate including a semiconductor nanocrystal in a binder. Bruchez does not teach a semiconductor nanocrystal in binder in a matrix on the surface of a substrate. Bruchez teaches making antigen-antibody

conjugates that include semiconductor nanocrystals in order to detect an analyte in a sample. See columns 23 and 24 of Bruchez. Indeed, Bruchez does not even recognize that semiconductor nanocrystals exhibit any temperature dependence in their emission. As a result there is no motivation to combine Bruchez – a method for detecting an analyte in a sample-with Britton-a method of temperature measurement of a fluorescing phosphor. Without such a recognition or suggestion, there is no motivation in Bruchez to use a semiconductor nanocrystal in a temperature sensor.

Neither Bruchez nor Britton disclose using semiconductor nanocrystals as thermal sensors inside a binder or alone. Neither reference suggests that semiconductor nanocrystals might exhibit differing intensities based on the temperature of their environment. Neither suggests using semiconductor nanocrystals in a binder to form a matrix on the surface of a substrate. Finally, the requisite motivation to combine the references has not been provided. The cited references must provide some suggestion, motivation, or teaching for combining known components. See Heidelberger Druckmaschinen AG v. Hantscho Commercial Prods., Inc., 21 F.3d 1068, 1072, 30 USPQ2d 1377, 1379 (Fed.Cir.1994) ("When the patented invention is made by combining known components to achieve a new system, the prior art must provide a suggestion or motivation to make such a combination."); C.R. Bard, Inc. v. M3 Systems, Inc., 157 F.3d 1340 (Fed. Cir. 2000). The requisite motivation to combine the references has not been provided Thus the Examiner has not presented a *prima facie* case of obviousness.

For at least these reasons independent claims 1 and 15 and the claims that depend from them are patentable over Britton in view of Bruchez. Applicants respectfully request reconsideration and withdrawal of this rejection.

Claims 24-33, 35, 36, 39-48, and 50

Claims 24-33, 35, 36, 39-48 and 50 have been rejected under 35 U.S.C. §103(a) as being unpatentable over the published article "Application of Temperature Sensitive Paint for Detection of Boundary Layer Transition" by Popernack *et al.* ("Popernack") in view of the published article "Oxygen Quenching of Luminescence of Pressure Sensitive Paint for Wind Tunnel Research," by Gouterman ("Gouterman") and Bruchez. Claims 24, 32, 43, 45, and 48 are independent.

Independent claims 24 and 48 feature a temperature sensing coating and a method of sensing temperature, repsectively. Both claims include a matrix on a surface of a substrate, the matrix including a semiconductor nanocrystal in a binder.

Independent claims 32, 43, 45, and 48 feature a temperature sensing paint, a method of manufacturing a temperature sensitive paint, and a method of manufacturing a temperature sensor, respectively. Each claim includes a semiconductor nanocrystal in a binder and a deposition solvent.

The Examiner states that

> Popernack discloses that temperature sensitive paints are used to measure the temperature of a surface. The temperature sensitive paint is applied evenly to a surface to produce a thin coating and has a light emitting element that emits light when excited by a light source. The intensity of the emitted light is detected to determine the temperature of the surface.

See Office Action at page 5. Applicants disagree. Popernack does not disclose any method of application of the temperature sensitive paint and does not identify any materials used in forming a temperature sensitive paint. In particular, Popernack does not disclose that a separate temperature sensitive light emitting element is added to the paint. As such, Popernack does not disclose any ingredients of the paint used in making a temperature sensitive paint.

Gouterman discloses that a pressure sensitive paint can be made from a luminophor, a binder , a volatile solvent, pigments and additives. Gouterman also requires the presence of Oxygen in order for its method to work. Gouterman does not suggest or teach any materials for sensing temperature or for making temperature sensitive paints. In fact, Gouterman explicitly recognizes an unmet need for a luminophor that could be combined with a pressure sensitive paint that was temperature sensitive in order to improve the pressure measurement method proposed. See Gouterman at page 701, second column, last paragraph. The teachings of Popernack do not add anything to the teachings of Gouterman. Indeed, Popernack lacks description of suitable materials for a temperature sensitive paint, such a combination would not be of any value. Popernack only reveals that temperature sensitive paints exist. The combination of Popernack with Gouterman reveals that pressure sensitive paints exist, that temperature sensitive paints exist, that pressure sensitive paints are made from a luminophor, a binder, a volaitle solvent, pigments and additives and that combinations of temperature sensitive

luminophors with pressure sensitive paints have been tried but were not successful. See Gouterman at page 701, second column, last paragraph.

Popernack and Gouterman in combination do not teach or suggest forming a temperature sensitive paint, or a matrix on the surface of a substrate including a semiconductor nanocrystal in a binder and a deposition solvent. Indeed, the combination does not suggest including a temperature sensing luminophor in a deposition solvent. See page 697, last full paragraph of Gouterman. There is no motivation to combine the teachings of Popernack with those of Gouterman. Such a motivation is necessary to establish a *prima facie* case of obviousness.

Similarly, there is no motivation to combine Popernack or Gouterman, or both, with Bruchez. Bruchez does not even relate to sensing temperature or pressure. Instead, Bruchez teaches a method of detecting an analyte in a sample. See Title of Bruchez. The Examiner asserts that it would have been obvious to one of skill in the art to take the paint of Popernack, modify it to make it out of a binder and a solvent as disclosed by Gouterman, and then add Bruchez's semiconductor nanocrystals to replace the temperature sensitive light emitting element of the Popernack paint. Applicants disagree. Bruchez teaches making antigen-antibody conjugates that include semiconductor nanocrystals in order to detect an analyte in a sample. See columns 23 and 24 of Bruchez. Indeed, Bruchez does not even recognize that semiconductor nanocrystals exhibit any temperature dependence in their emission.

Bruchez simply fails to cure the deficiencies of Popernack or Popernack in combination with Gouterman. As a result there is no motivation to combine Bruchez – a method for detecting an analyte in a sample-with Gouterman-a method of using pressure sensitive paint- and further with Popernack- an application of a temperature sensitive paint. None of the references suggests that semiconductor nanocrystals exhibit differing emission intensities based on the temperature of their environment. None of the references suggests that semiconductor nanocrystals can be used as temperature sensors, in temperature sensitive paints or coatings or in a method of sensing temperature. Furthermore, Gouterman explicitly requires an oxygen dependent luminophor (molecule or phosphor that gives out light) in order to perform the method described in Gouterman, yet the Examiner asserts that Bruchez indicates that semiconductor nanocrystals emit light independently of oxygen pressure. As a result, Gouterman teaches or at least suggests away from combining with Bruchez rather than motivating a combination of the two.

Importantly, the Examiner fails to make out a *prima facie* case for obviousness and appears to be using impermissible hindsight. There is no motivation provided for combining the teachings of the three references. Obviousness cannot be established simply by stitching together pieces of prior art using the patent as a template. Interconnect Planning Corp. v. Feil, 774 F.2d 1132, 1143 (Fed. Cir. 1985); see also Loctite Corp. v. Ultraseal Ltd., 781 F.2d 861, 873 (Fed. Cir. 1985) (denouncing courts' tendency to depart from proper standard of nonobviousness "to the tempting but forbidden zone of hindsight."); In re Fine, 837 F.2d 1071, 1075 (Fed. Cir. 1988) ("One cannot use hindsight reconstruction to pick and choose among isolated disclosures in the prior art to deprecate the claimed invention."); In re Dembiczak, 175 F.3d 994, 999 (Fed. Cir. 1999) ("Our case law makes clear that the best defense against the subtle but powerful attraction of a hindsight-based obviousness analysis is rigorous application of the requirement for a showing of the teaching or motivation to combine prior art references."). Moreover, as discussed above, the requisite motivation to combine the references has not been provided.

For at least these reasons independent claims 24, 32, 43, 45, and 48 and the claims that depend from them are patentable over Popernack, Gouterman and Bruchez. Applicants respectfully request reconsideration and withdrawal of this objection.

Claim 34

Claim 34 has been rejected under 35 U.S.C. § 103(a) as being unpatentable over Popernack, Gouterman, and Bruchez as applied above in view of the article entitiled "Pressure and Temperature Measurements with Dual-Luminopohor Coating" by Carroll *et al* ("Carroll"). Claim 34 depends from independent claim 32.

Independent claim 32 describes a temperature sensitive paint including semiconductor nanocrystals in a binder and a deposition solvent. As previously discussed, the combination of Popernack, Gouterman, and Bruchez fail to make claim 32 obvious because, in part, they fail to teach, suggest or motivate one skilled in the art to use semiconductor nanocrystals in a binder and a deposition solvent as a temperature sensitive paint. Carroll does not cure this deficiency. Carroll discloses paint with two light emitting elements, one for determining temperature of a surface and one for determining pressure on a surface. See Office Action at page 7. Carroll does not add what is lacking in the above combination. Carroll does not mention teach, or suggest

using semiconductor nanocrystals in a binder and a depostion solvent in a temperature sensitive paint.

In addition, the Examiner has failed to provide motivation for combining Carroll with Popernack, Gouterman, and Bruchez. A motivation for combining references in an obviousness analysis is a vital and necessary element. That element is lacking in this case. Accordingly, the Examiner has failed to make out a *prima facie* case of obviousness.

For at least these reasons independent claim 32 and claim 34 which depends therefrom are patentable over the combination of Carroll with Popernack, Gouterman, and Bruchez. Applicants respectfully request reconsideration and withdrawal of this rejection.

Claims 37 and 38

Claims 37 and 38 have been rejected under 35 U.S.C. § 103(a) as being unpatentable over the combination of Popernack, Gouterman, Bruchez and prior art disclosed by applicants on page 8, lines 27-29 of the specification ("Prior Art"). Claims 37 and 38 depend from independent claim 32.

As discussed above for claim 32, Popercak, Gouterman and Bruchez do not render independent claim 32 obvious. Examiner refers to the term typical in Applicant' s specification and asserts that the term renders the material after it prior art. This assertion is incorrect. The material following the term "typical" is not prior art, is not intended to be prior art, and does not cite prior art. The Examiner is impermissibly attempting to use portions of the Applicant's specification as prior art to make this rejection. Clams 37 and 38 are patentable for the same reasons previously discussed in relation to independent claim 32. In addition, the Examiner does not provide any motivation for combining Popernack with Gouterman, Bruchez and Applicants' specification.

For at least these reason claim 32 and the claims that depend from it are patentable over the cited references. Applicants respectfully request reconsideration and withdrawal of this rejection.

Attached is a marked-up version of the changes being made by the current amendment.

CONCLUSION

Applicants ask that all claims be allowed. Please apply any charges or credits to Deposit Account No. 06-1050.

Respectfully submitted,

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Version with markings to show changes made

In the claims:

Claims 1, 35 and 36 have been amended as follows:

--1. (Amended) A method of sensing temperature comprising:

providing a temperature sensor including a matrix on a surface of a substrate, the matrix comprising a semiconductor nanocrystal in a binder;

irradiating a portion of the sensor with an excitation wavlength of light;

detetcting the emission intensity of light from the sensor

determining the temperature from the emission intensity of light from the sensor.--

--35. (Amended) The paint of claim 34**[32]**, wherein the pressure-sensitive composition includes a porphyrin.--

--36. (Amended) The paint of claim 35**[32]**, wherein the porphyrin is a platinum porphyrin. --